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of this form with the vomerine teeth, discovered by Baur, and refers to their relationship to similar teeth in Paleohatteria.

Dr. Emil Schoebel contributes¹² an account of the post-embryonic development of the eye of the Amphibia. The eye has almost all of its essential features at the beginning of larval life, and, contrary to the title of the paper, the author describes the features before as well as after hatching.

EMBRYOLOGY.¹

A New Text-Book on the Embryology of Invertebrates.

—Dr. E. Korshelt and Dr. K. Heider have recently published the first volume of a "*Lehrbuch der Vergleichenden Entwicklungsgeschichte der Wirbellosen-Thiere*" (Jena, 1890, Gustav Fischer). Since the publication of Balfour's "*Treatise on Comparative Embryology*," written more than ten years ago, there have been published an immense number of papers dealing with the embryology of animals; and the authors believe there is a pressing need of bringing these together, and making a new inventory of the accumulated material. The present book is confined to the results on invertebrates, inasmuch as the papers on vertebrate embryology have been brought together, within the last few years, in well-known treatises on the subject. The first volume treats of the Sponges, Cnidaria, Ctenophora, Platyhelminthes, Nemertines, Nemathelminthes, Annelids, Echinoderms, and a few smaller groups. In the second volume the authors promise to treat of the Arthropods, Molluscs, Molluscoids, Tunicates, and Amphioxus; and the book will close with a general part.

The substance of the first volume is largely made up of reviews of the most important papers published since Balfour's time, and, so far as we can judge, these are admirably presented, and are noticeable for clearness as well as conciseness of statement. The authors believe fully in the evidence of embryology to solve most of the problems of phylogeny. They hold fast to the gastrula ancestry of the Metazoa, and each larval form is marshaled up to tell its tale of how the groups arose. This diagrammatic conception certainly admits of clearness of treatment; but whether it represents the high-water mark of morphological speculation may be open to doubt.

¹² *Zool. Jahrbuch*, Abth. Anat. Ont., IV., p. 297, 1890.

¹ Edited by Dr. T. H. Morgan, Johns Hopkins University, Baltimore, Md., to whom books and pamphlets for review should be sent.

Each of the sections ends with a general part, in which the authors bring together the essential points of the papers on the subject, and give their interpretation of the meaning of the facts.

The first section, on the Sponges, is admirable, and a much better-balanced presentation than that given by Balfour, who has unduly emphasized the amphiblastula larva. They believe the Sponge is a distinct phylum, only connected with the other Metazoa in its earliest history,—“nur an seiner Wurzel.” The group has a true blastula and gastrula stage, but believing the polyp to represent the ancestral Cœlenterate, they do not think the Sponges have any affinity with the latter group. For the Cœlenterates they adhere to the old views that the fixed Hydroid represents the ancestral form, and the Medusæ a higher, more specialized, and later form; and they reject the free-swimming jelly-fish as an ancestral form, as held by Claus, Brooks, and Vogt. The authors are inclined to believe in the gastrula as the ancestral form of the Cnidaria, and think a secondary change has come into the ontogeny “because the typical larval form of the Cnidaria is the planula. It is probable that the transition of the free-swimming, gastrula-like ancestor was changed into the fixed polyp form through a creeping stage, which the creeping planulæ of many forms now repeat in their ontogeny.”

The Ctenophors have many general points of agreement with other Cœlenterates, but recent work (Hertwig, Lang, Hatschek) goes to show that the Ctenophors have had an independent origin. They show no evidence of a polyp ancestry in the ontogeny, and the formation of organs shows they have no close relationship to the Medusæ. To sum it all up, the Ctenophors represent an independent phylum of the animal kingdom, and only at the base unite with the Cnidaria.

The Turbellarians show many common characteristics in segmentation and gastrulation with the Ctenophors, but if these two groups came from the same root, each has become so changed that only general resemblances are possible.

The Trematodes go back to Turbellarian-like flatworms which have assumed a parasitic life. The Nemertines, although more highly developed, are probably related to the flatworms, and it is not possible to separate Nemertines from the Turbellarians in order to place them among the segmented worms. Hubrecht's hypothesis as to the relationship between Vertebrates and Nemertines can have only an entirely speculative value. The embryology of the Nematelminthes throws no light upon their ancestry, and we cannot determine whether they are related to the Nemertines on the one hand, or to the Annelids on

the other. The Rotifers go back to the Trochophora, and Semper's Trochosphaera shows this relationship.

The Annelids include Chætopods, Echiuriden, Dinophilus, Myzotoma, Hirudinea, Branchiobdella.

The treatment of the group is interesting, and brings out clearly the tendency of the authors to overestimate, as I believe, the value of embryology as affording a solution to phylogeny. The Trochophore larva is the typical larval form of the Annelids. It is exceedingly probable that the Trochophore of Annelids is a recapitulated stage of an ancestral form of the group which was common to the Annelids, Mollusca, and Molluscoida, and from which these groups diverged. It is difficult to determine from what ancestors the Trochophore itself arose. The authors give their reasons for rejecting the Medusæ as the ancestors of the Trochophore. They conclude that the facts indicate that the Trochophore developed directly out of a ciliated gastrula-like forefather, and by a change in the method of progression. The transition of the Trochophore-like ancestor into the typical Annelid (Archiannelid) took place by an increase in the length of the body and a diminution of the head. At the same time a change from a free-swimming to a crawling animal took place, and this process is repeated in the ontogeny of living Annelids. The Sipunculids show resemblances to the Annelids, but cannot certainly be referred to that group; and their resemblance to Phoronis and Molluscoids is not sufficiently established. The Chætognatha are perhaps most nearly related to the Annelids.

The Tornaria of Balanoglossus shows certain resemblances to Echinoderm larvæ, but it appears to be only in external and non-essential characters, and the Tornaria comes nearer to the Trochophore. There is some uncertainty as to the relationship of Balanoglossus to the Chordata.

The radial structure of the Echinoderms is due to the ancestral form having been fixed and subsequently become a free-living animal. To what group of the Bilateralia these go back to is "in der Luft." (I cannot believe the authors have fairly treated the apparent relationship, as Metchnikoff has pointed out, between the Echinoderms and Balanoglossus, through perhaps a Holothurian form.) The larva of the Echinoderms, they think, comes nearest to the Trochophore.

Whether or not we agree with these more speculative parts of the volume, the general verdict seems to be that the authors have produced a useful book. An English translation would probably appeal to a larger audience and excite a wider interest in embryology.

Amphioxus.—Prof. E. Ray Lankester and Mr. Arthur Willey have a paper on “The Development of the Atrial Chamber of Amphioxus,” in the *Quar. Jour.* for Aug., 1890. Mr. Willey made some observations in Sicily on the life of the adult and the embryo which are of interest. The adults will spawn in glasses, and this takes place about an hour after sundown. The eggs must be distributed into glasses containing clean, unfiltered water from the pantano in which the adults live. “If the water is filtered, or if sea-water [outside of the pantano] is employed,” the eggs “will either die or develop abnormally.” Most, if not all, of the ova were discharged through the atriopore, which contradicts the statement of Kowalevsky, who says they issue from the mouth.

The young larva rests habitually on one side, and does not bury itself in the sand. The larva shows for a time the most marked asymmetry, with the mouth on one side and a single row of gill-slits on the other.

The young Amphioxus, after regaining its symmetry, does not lie on its side, “but buries itself upright, tail downwards, with the oral hood alone projecting from the sand.” The spawning occurs from April to September, inclusive.

The greater part of the paper is taken up with a description of the formation of the atrium and of the organs in the head region.

The Life-History of the Red Blood-Corpuscles.—Prof. W. H. Howell, of the University of Michigan, has a most important and interesting paper on the origin of the corpuscles of the blood. A rather full abstract of this paper is given below, as the subject is one of great interest to all students and teachers of physiology, and is either treated in a most meagre way, or, worse still, false statements are not infrequent in many of our text-books of physiology. Those who care for a fuller account will find Dr. Howell’s paper instructive (*The Journal of Morphology*, Vol. IV., No. 1):

“Before 1869 it was quite generally believed that the red corpuscles are formed from the white corpuscles, most probably while in the circulation,” but “the evidence is overwhelming against this view. In the very young embryo two forms of red corpuscles are found,—one large, oval, and always nucleated, resembling the corpuscles of the lower vertebrates; and one small, biconcave, circular in outline, and found both nucleated and non-nucleated. The latter are the true mammalian corpuscles; the former represent possibly ancestral corpuscles. The true mammalian corpuscles lose their nuclei by extrusion.

The nuclei of the nucleated red corpuscles of the *young* embryo (except of the larger variety) are lost while in the circulation. . . . As the embryo grows larger, and the production of new corpuscles becomes localized in different organs,—liver, spleen, marrow,—more and more of the early history of the corpuscles is passed over while still in the blood-forming organ, and more and more of the red corpuscles are sent into the blood in the non-nucleated stage. In the first part of embryonic life new red corpuscles are produced in the liver from groups of mesoblastic cells, outlining the position of future blood-vessels (veins). It is probable that new red corpuscles are formed in all parts of the body where blood-vessels are being developed.” This view of the origin is essentially different from that of Klein and Balfour, as given in the “Embryology of the Chick,” where it is asserted that the red corpuscles are endogenously *within* large mesoblastic cells. “In the second half of embryonic life red corpuscles are formed in the liver, the spleen, and the marrow of the bones, the function being most active first in the liver, then in the spleen, and, finally, in the red marrow of the bones, where it continues during adult life.

“The white corpuscles and blood-plates do not occur in the circulating blood of young embryos, but make their appearance in later embryonic life.” Certain nucleated cells of the red marrow of the bones multiply by division, later loose their nuclei by extrusion, and getting into the blood become the red corpuscles, and the biconcavity of these corpuscles may be due to the extrusion of the nucleus.

The white blood corpuscles are derived from the lymph leucocytes. These enter the circulation, and are at first not amœboid. The nucleus increases in size as the leucocyte grows older; finally it fragments, and probably this is followed by disintegration of the whole cell. The fragments of the nuclei persist for a time as the blood-plates. See Minot in *NATURALIST*, November, 1890.

Appendages of the First Abdominal Segments of Embryo Insects.—Mr. Wheeler has made a comparative study of the larval appendages of the first abdominal segment of insects (Trans. Wisconsin Acad. Science, etc.) He concludes that the appendage—the pleuropodia—of this segment were at one time organs of considerable functional importance in the primitive Hexapods, but are not equally well represented in the larva of all existing groups. They are serially homologous with the appendages of the thorax and abdomen, and in the embryos of existing insects these rudimentary structures

are found as evaginations or invaginations of thickened ectoderm. Rathke, Ayers, and Graber believe these rudimentary appendages represent embryonic gills. Wheeler objects to this interpretation, as the cells of the pleuropodia are large, swollen, vacuolated structures, and would prevent any great interchange of gases between the blood and the air. Nor could these pleuropodia be sense organs, as Patten and Cholodkovsky believed, for no one has discovered even the trace of a nervous system running into them. The author is led to the belief that the organs must be large ductless glands, which were functional in ancestral insects. It seems probable that the pleuropodia represent appendages homologous with the thoracic legs, and may have been, at a remote time, ambulatory appendages, and subsequently converted into functional glands in the ancestors immediately preceding living insects.

Are the Arthropods the Ancestors of the Vertebrates?—

Two papers of a speculative nature have appeared side by side in a recent number (Aug., 1890) of the *Quarterly Journal of Microscopical Science*. The contrast between these cannot be without its value. Dr. William Patten, of the University of North Dakota, Grand Forks, U. S. A., makes the first attempt to establish "the origin of vertebrates from Arachnids." The other production comes from Cambridge, England, and is advanced by W. H. Gaskell, M.D., F.R.S., to establish "the origin of vertebrates from a Crustacean-like ancestor." It is difficult to bring one's self into the proper mental condition to treat these matters seriously; but that the authors, especially Gaskell, are in dead earnest there can be no doubt.

Patten seems to have been led to his hypothesis in studying the anatomy and embryology of Scorpions and *Limulus*; while Gaskell, if we remember aright, was started towards his present goal by the resemblance between *tumors* in the spinal cord and in the digestive tract.

A detailed review of these papers is impossible here, and the barest outline must suffice. Briefly, then, Patten inverts a *Limulus*, or a scorpion, or anything similar, and proceeds to compare the principal organs of his up-side-down beast with a vertebrate right-side-up, proving the identity of the structures! The most important comparison is between the nervous systems of the two groups. The three brain vesicles of the vertebrate find their homologue in the supracæsophageal and fused thoracic ganglia of the scorpion. The cranial nerves of the vertebrate are the results of the first *thirteen* neuromeres of the Arach-

nid. (The fatal number *thirteen* seems unfortunate just at present—see Dohrn !) Then follows a lengthy comparison between the vagus of the vertebrate and a series of nerves from the posterior part of the thoracic cord, and a comparison between the eyes of the two groups. The cranial flexure of vertebrates is entirely explained in the relationship of the supracæsophageal ganglion (fore- and mid-brain) of the scorpion to the thoracic ganglia. The notochord finds its homologue in the “median furrow” of Arthropods, which comes from the *ectoderm*, and the support of this homology is found forthwith in our ignorance of the origin of the vertebrate cord ! “Only a strong faith in enteric diverticula, and in the red, white and blue gastrules of embryological treatises, can lead one to the belief in the entodermic origin of the notochord. On the other hand, its growth at both ends from superficial cells, and the manner in which it is frequently wedged in between the nerve cords, indicate its ectodermic origin.” This is an excellent example of the author’s scientific state of mind in treating so important a question as the origin of the vertebrates !

The gill-slits come from the rudimentary nephridia of the thorax, and somehow—it doesn’t matter much, since they must—connect secondarily with the digestive tract.

The fossil fish *Pterichthys* probably shows the transitional form between *Limulus* and the vertebrates. The mouth of the latter group is a new affair, coming from a dorsal sucking organ of our ancestors, and our other *Limulus*-mouth has long since disappeared.

Our views of gastrula and blastopore must be rejected, and newer ideas received, which will show a wonderful similarity between Arachnids and vertebrates.

Gaskell, in a former paper, demonstrated how the nervous system is composed of nervous material grouped around a central tube, which tube was originally the alimentary canal of an invertebrate. The present paper shows, he thinks, that the lowest vertebrate nervous system (*Ammonoetes*) confirms his theory. The old invertebrate digestive tract is now the central canal of the nerve cord. Of course the vertebrate now turns over, and a new digestive tract arose from the *gill region* of the Crustacean (how the author includes *Limulus* in this process is not yet clear to us, for *Limulus* he includes in his Crustacea). Nor does the author, yet a while, explain how a new mouth arose ; perhaps he has not finally settled on a convenient Arthropod organ. The ventricles of the vertebrate brain and the *canalis centralis* of the cord is the invertebrate ancestor’s digestive tract, and the *infundibulum* of *Ammonoetes* is the old oesophagus and mouth.

The pineal eye of the vertebrate may be reduced back to the three-layered Arthropod type. There is another more rudimentary pineal eye which belongs to the left side, while the previous one connects with the right ganglion habenulæ. The brain of *Ammocætes* almost compels us to recognize the supracéphalæal ganglion of the Crustacean, etc.

If any one hopes to find a grain of truth in either of these two contradictory theories, which exhibit wonderful displays of mental gymnastics, starting from the Arthropods as from a spring-board, thence to take their aerial flight, let such a person read them side by side.

ENTOMOLOGY.¹

A Review of Some Plum Curculio Literature.—A few years hence, when it is finally and definitely settled whether the Plum Curculio (*Conotrachelus nenuphar*) can be successfully fought on a commercial scale by spraying with the arsenites, there will be an opportunity to write a most curious and instructive chapter in the annals of economic entomology. This question has been under discussion by entomologists for more than twenty years, and to judge from the latest publications concerning it, the end is yet in the distant future. Nearly all our economic entomologists have taken part in the discussion, and the final record will show a curious mixture of assent and dissent on the part of those concerned.

Before attempting a brief analysis of this record, I desire to quote from a letter recently published in *Agricultural Science* (Vol. IV., p. 97), in which I made the following statements concerning the philosophy of spraying with the arsenites, and the conditions necessary for a fair test: "The remedy undoubtedly acts mainly by destroying the adult beetles that feed upon the poisoned surface of the fruit and foliage, thus preventing, to a greater or less extent, the deposition of the eggs. It need not necessarily act at all upon the beetles when engaged in oviposition, nor upon the larvæ after hatching. Consequently a fair test cannot be carried on with a half dozen trees close together, three of which are sprayed and the others not. Beetles from the unsprayed trees may oviposit in the fruit of those sprayed, and the beetles killed on the sprayed trees will lessen the injury to their checks. For the same reason a fair test cannot be carried on in an orchard in

¹ Edited by Dr. C. M. Weed, Experiment Station, Columbus, Ohio.